STANDARD FOR OFF-SITE STABILITY

Definition

A condition below and beyond the immediate limits of the site or property where the soil and related natural resources are subject to damage directly or indirectly by the discharge of stormwater runoff.

Purpose

To protect and maintain the stability and integrity of natural resources on downstream or off-site property due to changes in the rate and volume of stormwater runoff associated with construction activity and of land development.

Conditions Where Practices Applies

For purposes of analysis two areas of concern shall be addressed: (1) at the point of discharge and (2) downstream of the discharge point (which may require a watershed-based analysis).

Technical criteria for demonstrating off-site stability include consideration of proximity to a defined waterway, site topography (slope), soil texture, vegetative cover and other factors. Where the potential for erosive forces from stormwater runoff exceeds the threshold of acceptability as defined below, the plan shall provide for the construction of a stabilized channel, installation of a conduit to a stable condition or other types of hydraulic improvements to the channel.

Water Quality Enhancement

Stormwater runoff is that portion of precipitation that returns to water bodies over the surface of the ground. The amount of stormwater runoff in a given area is a function of several factors including but not limited to: the amount and intensity of precipitation, soil texture, vegetative cover and slope. Unless properly managed stormwater runoff can adversely affect the environment through increased flood damages, increased erosion and sedimentation, increased waterway surges, destruction of vegetation, impaired water quality and increased turbidity. By addressing these factors in combination with one another this standard provides guidance for the design of off-site stormwater discharge which will result in minimized environmental impact and the long term protection of downstream water quality.

Design Criteria

This Standard involves two areas of analysis: (1) at the point(s) of stormsewer discharge and (2) beyond the site boundaries, typically a receiving channel or waterway. Stability documentation for each area is outlined in detail below. Generally the analyses involve the manipulation of peak rates of discharge for the 2 and 10 year, 24 hour storm events such that peak flow rate values and velocities are below established thresholds. Discharges shall be located in areas with low gradient topography and covered in perennial erosion resistant vegetation as noted in table 21-1 below.

Special consideration shall be given to the use of infiltration for peak flow modifications as follows:

Point of Discharge Stability Analysis

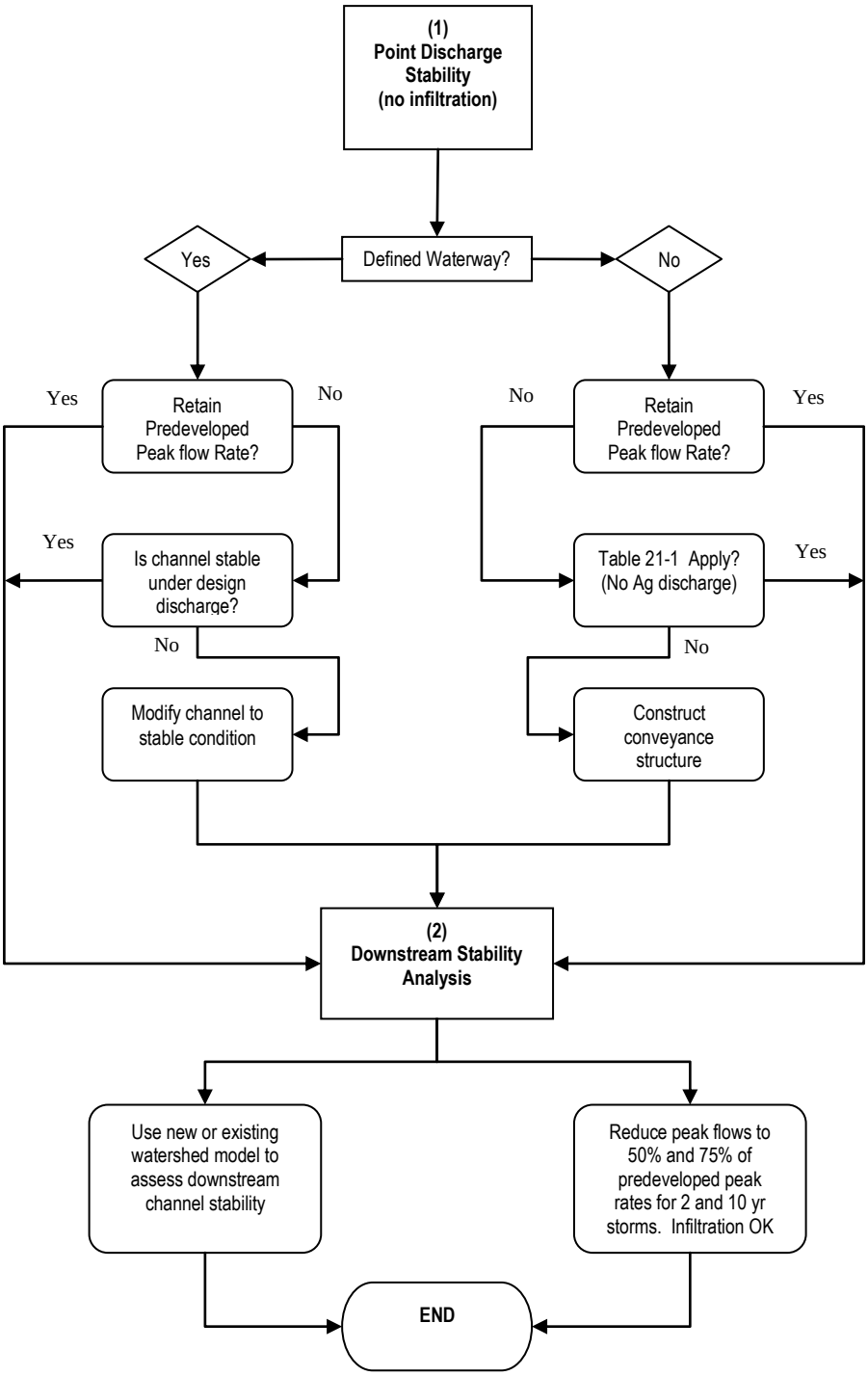
When infiltration practices are proposed, an alternate analysis (failure analysis) must be provided which ignores infiltration (no dead storage volume available, no static or dynamic infiltration loss rates in the routing calculations, etc) and demonstrates that no erosion will occur at the point of discharge if infiltration fails to function. Flow rates based solely upon basin inlet and outlet hydraulics must be used in comparison to table 21-1 (below) to document a stable outlet.

Downstream (off-site) Stability Analysis.

Infiltration may be used to meet peak flow reduction requirements (outlined below) for the purposes of documenting stability of the downstream receiving channel, provided that the complete loss of infiltration function does not result in an increase in peak flow values above the predevelopment levels..

A generalized procedure for assessing point and offsite stability is depicted in figure 21-1:

Figure 21–1
Point Discharge and Downstream Stability Analysis Procedure



Point of Discharge - Methods for Achieving Stability

1. **No well-defined waterway below the point of discharge**:

   Stability cannot be achieved by the allowable velocity method since there can be no determination where the runoff will concentrate. A land-form not previously subjected to concentrated water flow will become unstable.

   Stability can be achieved by one of the following alternatives:

   a. Retain pre-existing runoff characteristics. Do not increase the amount and rate of runoff for the development and **do not concentrate flows**.

   b. Where there is no well defined channel, no sandy condition, no trees or brush to substantially concentrate the flows and it can be reasonably assumed that the flow will disperse over a broad area. The combinations of slopes and soils in table 21-1 and the following criteria are considered stable for flows of 10cfs or less for a 25 year, 24hr design storm.

Table 21-1 Non-Erosive Velocities for Point Discharges

Maximum Stable Slope for Point Discharges for Various Soils	
Soil Type	**Perennial, Natural Vegetation**
	Maximum Slope (%)
Sands	1.8
Sandy loam	2.0
Silt loam, loam	2.5
Sandy clay loam	3.5
Clay loam	5.0
Graded loam to gravel	8.0

Stability Criteria (in conjunction with table 21-1)

i. The maximum discharge rate shall be 10 cfs or less for the twenty-five (25) year storm.

ii. Multiple outlets may be utilized to reduce individual outlet flow rates to levels below the thresholds noted above. Outlets should be spaced no closer than 50 ft horizontally to avoid re-mixing of flows

iii. Flow over the outlet area shall be less than 0.5 cfs/ft. Designers shall not design excessive widths which will cause flows to concentrate.

iv. Conduit outlet protection shall be provided in accordance with that Standard and may include: flat aprons, preformed scour holes, impact basins, stilling wells, plunge pools, etc. **Level spreaders are not an acceptable design**.

v. Topography shows broad uniform outlet area where flows will not concentrate.

vi. Discharge locations shall contain perennial, erosion resistant vegetation

vii. Peak discharge velocities (in the last pipe section) do not exceed 2 fps.

viii. The maximum length of slope below the outlet(s) is 100 feet

c. Construct conveyance structure (pipe or channel)

i. Pipe to a stable condition. When constructing a pipe through wetlands, an impervious trench shall be required. The pipe trench shall be compacted and filled with impervious material instead of the classic stone filled trench. The Conduit Outlet Protection Standard shall be adhered to.

ii. Construct a channel pursuant to the Standards for:
- Channel Stabilization
- Grassed Waterways
- Lined Waterways
- Rip Rap
- Soil Bioengineering

Discharge to Agricultural Lands

Conditions represented in table 21-1 (and following) presume the presence of perennial, natural vegetation and in-situ, undisturbed soil conditions. Agricultural lands which are routinely disturbed due to cultivation and harvesting practices do not conform to the presumptions of this model and are therefore not suitable locations for point discharge. Generally, discharges to actively cultivated agricultural lands will require the construction of a conveyance structure across fields and land owner permission to discharge stormwater. Verification of landowner permission along with all appropriate engineering designs must be submitted to the soil conservation district to be considered for plan certification

Note: Some form of detention may be required in conjunction with the use of a constructed pipe or channel depending on the final discharge location. Consideration shall be given to the effects of an extended time of peak discharge duration as compared to the instantaneous peak discharge when detention is not used. Extended peak runoff may saturate the soil, destroy existing vegetation and loosen the soil to an eroding condition. If detention is required, the Standard for Detention Structures shall be addressed.

2. Well-defined waterway[1] below the point of discharge:

a. Retain pre-developed runoff characteristics. Do not increase the rate of runoff from development.

b. Analyze the waterway or channel for stability under the planned rate of discharge using the Standard for Grassed Waterways or Standard for Channel Stabilization, as appropriate. Peak flows from the 2 and 10 year storms shall be analyzed.

c. Modify the waterway or channel to a stable design condition.

Downstream of the Point of Discharge (Off-Site Stability Analysis)

In addition to ensuring erosion does not occur at the point of discharge, areas downstream and beyond the immediate area of site development may be damaged due to erosive forces resulting from extended duration of hydrograph peak flows. An unintended consequence of the practice of detaining and slowly releasing stormwater is the ability for peak flows to be sustained for longer periods of time, offering an opportunity for upstream discharges to coincide with project site discharges. The resulting combined discharge may be equal to or even exceed that of the pre-development condition.

To limit the potential for such an occurrence the designer may choose either of two approaches for **downstream stability** protection:

1. Examine hydraulic characteristics of the receiving stream channel considering upstream discharge in combination with site discharge to assess channel stability. The scope and scale of the analysis shall be appropriate to the scale of the project and the post development peak discharge rate and volume. Of particular concern are hydraulic control points, (culverts , bridges, etc.), bends in streams and sudden changes in channel cross sections downstream of the discharge point. The following may be utilized to assess stability:

    a. Utilize an existing watershed or regional stormwater management plan to verify the proposed discharge will not cause erosion downstream of the discharge point. The model should reflect the current conditions in the watershed.

    b Perform a new watershed analysis. Modeling multiple watersheds, routing stormwater structures and modeling water surface profiles shall be done, as necessary, to determine pre and post development velocities in channels and through structures.

    Analysis of the receiving channel shall include a comparison of pre and post condition velocities in the channel and overbank (if applicable) areas for the 2 and 10 year storm events. Cross sections and a scaled map of the section stations shall be included in the hydraulic analysis of the channel.

    In the event the analysis determines that the post development runoff must be controlled prior to discharge, some form of detention will be required. Refer to the Standard for Detention Structures for design requirements.

[1] "Waterway" shall be construed to mean an actual channel, gulley or topographic landform which has a discernable cross section.

2. In lieu of performing a comprehensive watershed analysis, design a detention facility that reduces peak flows to the following levels. Infiltration may be used to meet these criteria:

   2 year storm – 50% of the predevelopment peak
   10 year storm – 75% of the predevelopment peak

   Reductions in peak flows are to be compared to **predeveloped** drainage area points of discharge in the event that drainage is re-directed in the post developed condition. **Reductions are only required of the developed or modified portions of the project site.**

Plan Requirements for Documenting Stability

In addition to a complete hydraulic and hydrologic analysis described above, drawings must be submitted with the erosion control plan which show the predeveloped drainage condition for the proposed point of discharge along with the time of concentration flow path.